

DESIGN OF A 13,500 KW.  
STEAM - TURBO - ELECTRIC POWER PLANT

BY

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ARMOUR INSTITUTE OF TECHNOLOGY

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steam-turbo-electric power

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DESIGN OF A  
13,500 KW. STEAM-TURBO-ELECTRIC POWER PLANT.

## A THESIS

PRESENTED BY  
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TO THE

PRESIDENT AND FACULTY

OF

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HAVING COMPLETED THE PRESCRIBED COURSE OF STUDY IN

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## PREFACE.

In the design of this plant, the following points were considered as supplemental to the main problem in the selection and lay-out of the apparatus:

1. Maximum flexibility without too much and too complicated apparatus.

2. Accessability of apparatus for repairs and removal.

3. Future increase of output of plant.

4. Location of high tension apparatus to give maximum safety.

5. Plentiful supply of good water for condensing purposes.

6. Location of the plant made it desirable to have an attractive exterior of the building.

C.L.W.  
F.A.S.  
M.V.S.



## DESIGN OF A

### 13,500 KW. STEAM-TURBO-ELECTRIC POWER PLANT.

The power plant which is the subject of this thesis was designed to meet the following conditions:

A town of 20,000 inhabitants and two adjoining towns of 15,000 each, 30 miles distant, to be supplied.

Maximum power demand of 13, 500 KW at a power factor of 0.90 .

Steam-turbo-electric units to generate at 2200 volts.

Six transmission lines in town where plant is located.

Two transmission lines to each of the smaller towns.

A rotary converter substation to supply urban railway with 2000 KW. Substation to be located in power house.



THOUSAND K.W.







## SELECTION OF GENERATING UNITS.

The first point considered was the selection of the various generating units from consideration of the load curve.

From 12:00 M. to 6:00 A.M. the load is just below 2000 KVA, and a 2000 KVA unit was selected to cover this period. From 6:00 to 8:00 A.M. the load rises rapidly to about 7500 KVA and is then nearly constant, except for the noon drop, until about 3:00 P.M. A 6000 KVA unit was selected to cover this period with the aid of the 2000 KVA unit. These two units, with the assistance of another 6000 KVA unit, can cover the peak load. A third 6000 KVA unit is held in reserve so that breakdown or repairs on any of the other three units will not curtail the output of the plant. This also allows the increase of the output of the plant to 18,000 K. W. at the present power factor and equipment.

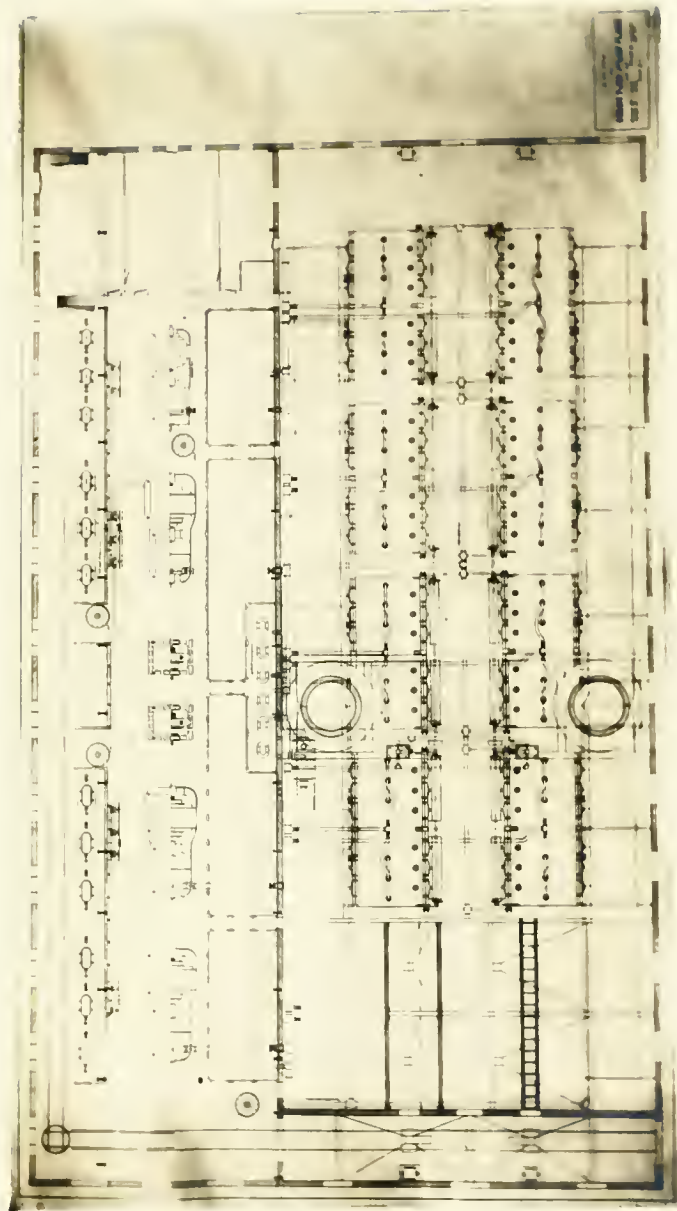
For the peak load, the small machine and two of the large ones can carry the load at about



10% overload, or the three large units can carry it at about 85% full load.

The object in selecting these units as was done was to have the plant operate at about the same efficiency on any load, since any machine which is operating will have nearly a full load and will therefore be operating at a high point on its efficiency curve. Since these machines can be operated at 25% overload continuously without injury, a considerable increase on any point of the load curve can be taken care of.







## THE BUILDING.

The building is 276 feet long and 166 feet wide, and is constructed of red pressed brick trimmed with Bedford stone. The floors and the basement walls are of reinforced concrete. The height to the top of the engine room monitor is 77 feet, and to the top of the boiler room monitor is 84 feet. The end walls are built up into two peaks two feet higher than the monitors and are capped with Bedford stone. The monitors will run the full length of the building with the exception of 20 feet on each end. The windows of the transformer gallery are 10 feet wide and 14 feet high, the upper portion being semi-circular. They are built in three vertical sections, the middle one of which is pivoted on a vertical axis. The control gallery is lighted by smaller rectangular windows. The high tension gallery is lighted from the engine room. The gallery walls, and also the engine room walls to the height of the first gallery, are of

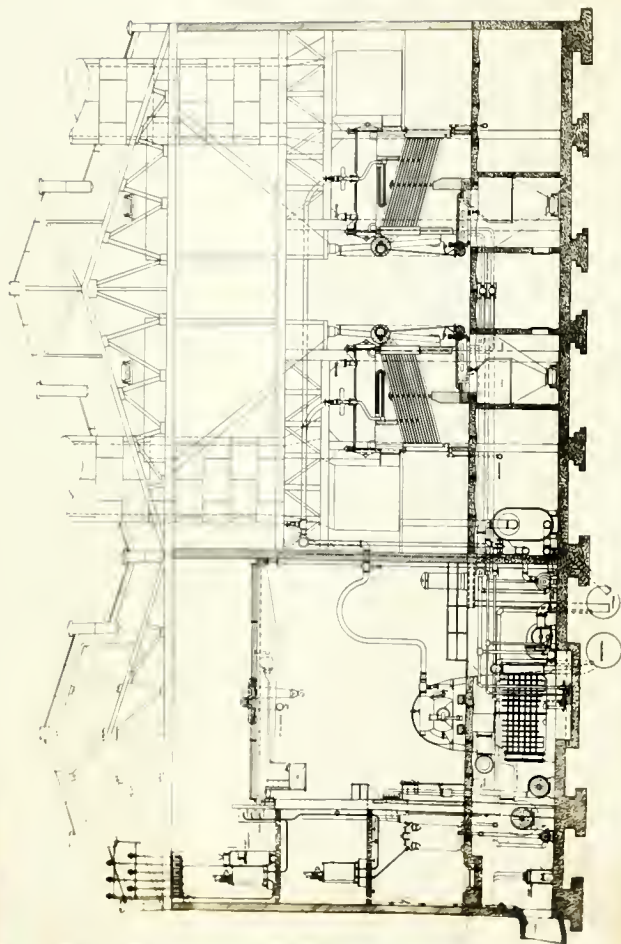




white enameled brick.

It was desired to have the gallery side of the building of neat and attractive appearance. For this reason the windows and door on this side are to be of fancy design. For the same reason no wires were brought out of this side of the building. The low tension feeders are taken out through a tunnel, while the high tension feeders are carried on the roof.





SECTION C-C  
STEAM TURBINE PLANT  
Scale: 1/4" = 1'-0"



## THE BOILER ROOM.

### Boilers.

Steam supply at 175 pounds pressure and 175 degrees superheat was chosen as that best suited for the turbo units used. The feed water supply is to be delivered at 200° F. Under these conditions, it was found that about 14,000 boiler horsepower was needed when operating the boilers at normal load. It was decided to install 15000 horsepower so as to allow for cutting out boilers for repairs without forcing the others, and also to allow for increase of output to correspond with the reserve capacity of the engine room. Because of the universal satisfaction afforded, 20 Babcock and Wilcox 750 boiler horsepower boilers were installed. These are placed in two rows of five batteries each, with a central firing aisle.

The boiler room is 276 feet long and 97 feet wide, with a height of 55 feet to the base of the roof truss. Above this truss is a



monitor with skylights eight feet high on each side, providing light and air to the boiler room through a 12-foot shaft extending the entire length of the building between the coal bunkers.

Each boiler is equipped with three 42 inch steam drums and superheater. Chain grate stokers are used, each bank of boilers having a reciprocating engine driving the stokers. These engines are located on the chimney superstructures. The width of firing aisle is sufficient to allow the grates or boiler tubes to be taken out without interfering with the operation of the boilers opposite.

#### Steam Headers.

Steam is delivered from the superheater through an expansion joint and valve to a header common to one battery of boilers. The headers from the various batteries deliver directly to the main 20 inch header through a gate valve placed close to the main header. This header





is supported on the wall between the boiler and engine rooms. Each turbo unit takes steam directly from the main header, valves being placed both at the header and at the unit. Three supply mains feed the header for the auxiliary apparatus in the basement.

#### Coal and Ash Apparatus.

Coal is delivered by the railroad on a track which enters one end of the boiler and engine rooms. The coal is dropped into two bunkers each having its own crusher and bucket conveyor. Storage bunkers run the length of the building above the boilers, the bunkers of the two rows of boilers being separated by the 12-foot ventilation shaft mentioned heretofore. The bunkers in each row join at the top so as to draw in all coal which the conveyors drop. The storage capacity is about 15 days fuel for the present daily output.

The conveyors are so located that they pass directly underneath the boiler grates.



Ashes and fine coal which drops through the grates are collected in separate chutes below the boiler. By opening a valve at the bottom of the ash chute the ashes can be conveyed to the ash bunkers over the coal track, where they can be delivered to the car through flexible spouts. The fine coal is taken back to the bunkers. The conveyors are carried underneath the boilers on the basement floor, while overhead they are supported on beams fastened to the roof truss. This arrangement of conveyors eliminates all handling of coal and ash by hand.

#### Chimneys.

One steel chimney, 13 feet inside diameter and 225 feet high, is provided for each row of boilers. They are set on steel superstructures above the rear of the boiler settings near the middle battery of boilers. The superstructure is partly supported by the boiler setting, the remainder of the weight being carried by columns resting on the building foundations.



The flues are carried behind the boilers on light I-beams set into the wall and the boiler settings. The flues are 12 feet wide and of variable height, depending on the distance from the stack.

#### Feed Water Piping.

All feed water piping is installed in duplicate to the point where the pipe enters the boiler setting. A Stillwell heater is located in the basement and supplies all feed water. This is drawn into a common header by the feed pumps located in the engine room basement, and is delivered to another header from which the two feed mains are taken. The feed mains are carried on the basement ceiling underneath the firing aisle. Two supply pipes lead up through the floor to globe valves delivering into a common pipe which enters the boiler. Only one feed main is to be used, the other being a reserve.



## THE ENGINE ROOM.

### Turbo Units.

The engine room runs parallel to the boiler room and is of the same length, with a width of 45 feet.

The four General Electric turbo-alternator units are placed lengthwise in the room with the two 1000 K.W. rotary converters in the middle. Each unit is set on a concrete foundation independent of the building. The generators are driven by seven stage Curtis turbines exhausting into horizontal Wheeler surface condensers of 18000 square feet area for the 6000 K.W. units and 7000 square feet for the 2000 K.W. units. The exhaust pipe between the engine and the condenser is provided with atmospheric relief valve for atmospheric exhaust in case of condenser failure. Motor driven governors are used for speed regulation. A small oil pump placed on the engine frame supplies oil to all bearings.

The alternators are delta connected and deliver 2200 volts at 60 cycles when running at





1800 r.p.m. At normal load the 6000 K.W. units can deliver 1575 amperes per phase, but they can be operated continuously at 25% overload, or 1970 amperes per phase. The 2000 K.W. unit gives 525 amperes per phase at normal load and 625 amperes at 25% overload.

Two fans driven by 2200 volt induction motors, supply air to the alternators, one fan supplying two machines. The air is delivered underneath and midway between the ends of the armature and leaves at both ends. The heated air passes out into the basement below the alternator.

#### Transfer Bus Connections.

A 9-inch wall of white enameled brick separates the engine room from the transformer room. This wall is divided into three sections, the middle one of 23 feet length being opposite the converters. The 2200 volt transfer bus is carried on this wall, the lowest bus being about 12 feet above the floor. The buses are connect-



ed by sectionalizing switches at the points where the wall is broken.

Opposite each alternator is a small panel board set out three feet from the wall. These carry the low tension switches and disconnects. The panels for the end machines carry two switches on the back, one for the alternator and one for the transfer bus. The disconnects are on the front of the panel, the lowest terminal being about nine feet above the floor. The other two boards carry a third switch which connects the two adjacent bus sections. In front of the middle bus section are panels for the converters, exciters, and motors.

#### Auxiliary Equipment.

Opposite the converters against the boiler room wall are placed the transformers which deliver power to the converters at the proper voltage. Each converter has its own transformer set, the units of the set being of 375 K.W. capacity. These are placed on a platform supported by I-beams. The transformers are air



cooled, air being delivered from two blowers driven by 2200 volt induction motors. Each set has its own blower, but the wiring is such that either blower can be used with either set.

A 50 ton crane equipped with a small auxiliary hoist spans the engine room. This is carried by I-beams resting on girders set into the wall. Material can be delivered directly to the engine room on the spur track and carried to any part of the room.

At the end opposite the track, a room 39 feet long has been partitioned off from the rest of the engine room. This is to be used as office locker and wash rooms. In case another unit is to be installed the offices can be moved to the second floor and the unit placed in the space left vacant.



## ENGINE ROOM BASEMENT.

### General.

All auxiliary apparatus for the engine room is placed in the engine room basement. All the auxiliaries are placed so that they can be moved to the open part of the engine room floor and lifted out by the crane without disturbing any other auxiliary. One exciter and the four blowers are motor driven; the air pumps are driven by reciprocating engines; all other auxiliary apparatus is driven by Curtis turbines. Against the boiler room wall are three main headers, one for exhaust steam, one for live steam, and one for condensed steam. The exhaust and condensed steam are returned to the heater through these mains.

### Condenser.

The Wheeler horizontal condensers are placed directly underneath the turbines and are supported by four short vertical columns. Below the condenser is a pit in the floor, three feet deep,





in which the 2 stage turbine driven condensed steam pump is placed. Volute circulating pumps are used, 24-inch intake and discharge pipes being used for the large units, and 18-inch connections for the smaller unit. Water is taken from the intake tunnel underneath the floor. The circulating discharge from the condenser is through a short vertical pipe to the discharge tunnel. The two tunnels are side by side directly underneath the auxiliaries. They do not, however, interfere with the engine foundations.

Wheeler dry vacuum air pumps are connected to the condenser at both front and rear ends.

#### Boiler Feed Apparatus.

The exhaust and condensed steam are delivered to the heater in the boiler room basement. This heater is equipped with overflow and low water floats. If the water becomes too low a small pump automatically draws water from the intake tunnel until the proper level is reached.



Three Alberger feed pumps each of 8000 boiler horse power capacity, are installed. These are connected in parallel between a header which leads from the heater and a header which leads to the two boiler feed mains. One of these pumps is installed as a reserve unit. By this arrangement, any pump can supply either feed main.

#### Cooling Apparatus.

The high tension transformers are water cooled, water being forced through by turbine pumps located in the basement. Each of the two pumps supplies two sets of transformers. The heated water is discharged to the discharge tunnel.

The blowers are located behind the engine foundations. Each blower supplies two alternators and is driven by a 40 H.P. 2200 volt motor with an R.P.M. of 600. Each can deliver 80,000 cubic feet of air per minute. The air supply is controlled by a regulator placed at the junction of the pipes. The blowers for the low tension transformers are placed behind the converter



foundations. Each is driven by a 2200 volt motor at 900 R.P.M. and can deliver 12,000 cubic feet per minute.

#### Exciters, etc.

The two exciters are located in front of the converter foundations. Both are of 200 K.W. capacity so that either can carry the total excitation load alone. One is driven by a 250 H.P. 2200 volt induction motor, while the other is driven by a non-condensing Curtis turbine. Excitation is at 125 volts, this value being chosen rather than 250 volts because of the smaller storage battery required for breakdown service. The 65 cell 800 ampere hour battery installed will carry the load for at least one half hour at maximum load on the plant. Power to operate the crane is taken from the excitation buses since this is only an intermittent demand. Station lighting is also carried by the exciters.

The lightning arresters and choke coils for the low tension lines are in the basement also.



## TRANSFORMER GALLERY.

The transformer gallery is 18 feet wide and runs parallel to the engine room. A 9-inch enameled brick wall separates it from the engine room, the wall being set just forward of the columns supporting the crane. Each alternator has its own set of transformers of capacity equal to that of the alternator. All transformers are of the single phase type and are connected in delta on both sides. A ground wire is put on one corner of the low tension delta and is taken to ground through a spark gap located in the basement. The high tension wires lead from the transformers directly up through the floor to the bottom of the high tension switches on the gallery above.

Behind the wall which carries the middle section of the transfer bus are located the low tension feeder switches and regulators. The low tension wires cross on the ceiling to the outside wall and go to the basement through disconnects.





## THE SWITCH AND CONTROL GALLERY.

On the second gallery are located the control board and the high tension transformer switches. The control board is of the bench board type, of marble with black marine finish, and consists of the following panels: four generator panels; two exciter panels; one high tension feeder panel; six low tension feeder panels; and two spare panels. The board is located at the middle of the room where the operator can see all parts of the engine room.

Above each set of transformers is a high tension motor-operated General Electric type H<sub>6</sub> oil switch. This type of switch has disconnects arranged to open from the front of the switch. The high tension wires leave the switch underneath the gallery floor and are carried up to the high tension gallery through enameled brick conduit compartments located at the engine room side of the gallery in front of the switches.



## THE HIGH TENSION GALLERY.

On the third gallery are located the high tension buses, feeder switches, and lightning arresters. The buses are located in compartments against the engine room wall of the gallery. They are divided into two sections by a high tension motor operated switch which is normally closed. All switches on this floor are of the  $H_6$  type. One high tension line is taken off of each side of the bus. Each of these lines then divided into two lines for each of the towns to which power is transmitted. This arrangement requires only one set of instruments for each town. The lines leave the buses through the floor and come up under the feeder switch. From the switch they run up the wall through a double throw disconnect to the choke coils. This disconnect normally closes the circuit, but when one line is cut out to make repairs the disconnect is thrown to the other side to ground the line. This increases safety in making repairs at any



point on a line in case power should accidentally be thrown on the line from some source other than the power house.

All choke coils are placed on the ceiling, and are separated from each other by marble slabs. The lightning arresters are of the four-tank aluminum electrolyte type, one set for each line leaving the building. The minimum distance between lightning arresters and switches is about 14 feet, each arrester being set next to its respective switch.

The wires are carried up through roof insulators to supports on the roof and are then carried to the ends of the building, where they span the street to the pole line. This was done to avoid marring the outside appearance of the building by bringing the four lines out at intervals along the wall. For the same reason, the low tension lines leave through the tunnel, as it was not deemed advisable to run them inside the building to the end walls.



## WIRING.

The following discussion will cover the main features of the wiring of the power house.

### Low Tension Connections.

The leads from the generators are separated in an end bell and enter separate conduits under the floor. The conduit has three compartments and is of vitrified clay set in concrete. The field leads are brought out in separate conduit. The leads rise behind the generator panel boards to the oil and selector switches. The selector switch has one double throw and one single throw switch with connections such that the alternator can be thrown on the transformers, transfer bus, or both. The oil switch which connects the alternator to the selector switch is of the  $K_{12}$  type and is non-automatic. For overload indication two lamps in parallel are placed on the control board, the lamp circuit being closed by an overload relay. Two lamps in parallel are used to





guard against the filament of one breaking. The oil switch which connects the alternator to the low tension bus is also of the  $K_{12}$  type and is non-automatic. The selector switches are placed between two marble slabs for protection.

The low tension buses are spaced 14 inches apart and are separated by marble slabs in order to secure protection against accidental short circuit. The buses are of  $\frac{1}{2} \times 10$  inch crosssection. The low tension bus bars are sectionalized by two type  $H_6$  switches in order to prevent all alternators being affected by a short circuit on one.

#### High Tension Connections.

The leads running from the selector switch to the low side of the transformers are of 2,000,000 circular mils area rubber covered copper cable. The leads leaving the high tension side of the transformers are of #00 rubber covered wire. The high tension oil switches between the transformer and the high tension buses are of the General Electric type  $H_6$  switch. The high ten-



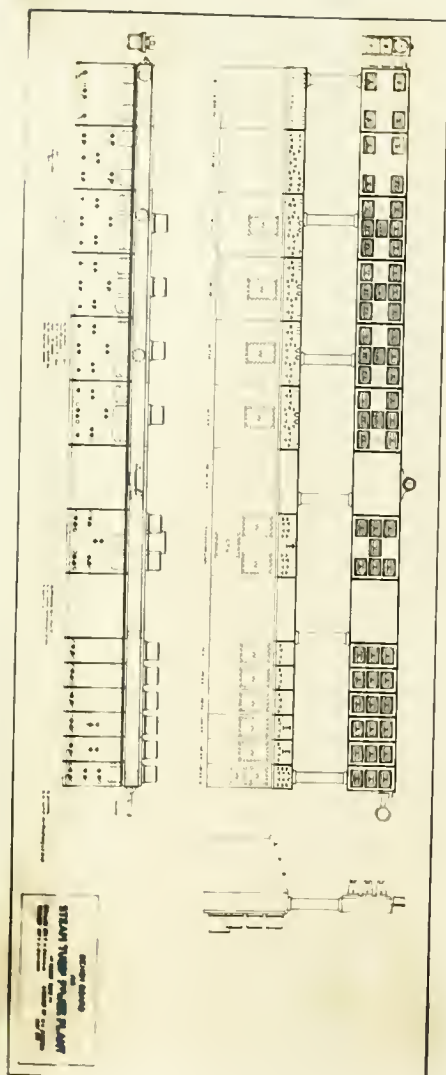
sion buses are of #0000 bare copper wire and are separated by marble slabs. The spacing is 20 inches center to center. The high tension bus is sectioned by a type H<sub>6</sub> oil switch to facilitate repairs and give flexibility.

The high tension feeder switches are also of the automatic type H<sub>6</sub>. The switches for the two lines to one town are interlocked for use when only one line is wanted in operation. Each line has a double throw disconnect switch, one side of which is grounded to give protection to linemen when repairing the lines. Each line leaves the disconnected ~~ed~~ through choke coils located on the ceiling between marble slabs. Horn gaps and electrolytic lightning arresters are tapped off through disconnects.

#### Low Tension Lines.

Each of the low tension lines leaves the low tension buses through an automatic K<sub>3</sub> switch. The low tension buses feed the following 2200 volt lines:







3 Three phase power, 675 K.W. each.

2 Three phase light, 475 K.W. each.

3 Single phase light, 150 K.W. each.

The three phase power lines deliver power directly to the consumers. The three phase lighting lines deliver to substations where regulators are located. The single phase lines have regulators in the power house and deliver directly to consumers.

#### The Control Board.

As previously mentioned the control board consist of two exciter panels; four alternator panels; one high tension feeder panel; six low tension feeder panels; and two spare panels. One of these spare panels is for the fifth generating unit, and the other for another power line when needed.

The first of the exciter panels carries two voltmeters and two ammeters, one each for the storage battery and one for the exciter. The keyboard has two ammeter receptacles by which the





charging and discharging current of the battery can be read. The battery is arranged to charge with the two halves in parallel and discharge all in series. A voltmeter receptacle is provided to give the voltage over either half of the battery, or the whole. The keyboard has keys for field rheostat control, field circuit breaker control, and battery rheostat control. The second exciter panel has one A.C. ammeter and a power factor meter for the induction motor and a D.C. voltmeter and ammeter for the exciter. The keyboard has the following keys: three  $K_3$  control switches for operating the induction motor, one field circuit breaker control, one field rheostat control, and one equalizer circuit breaker control.

Each generator panel carries three ammeters, one voltmeter, one polyphase indicating wattmeter,, one power factor meter, and one field ammeter. Also two overload indicating lamps. A polyphase recording wattmeter is mounted on the back of each panel. The keyboard has the following keys:



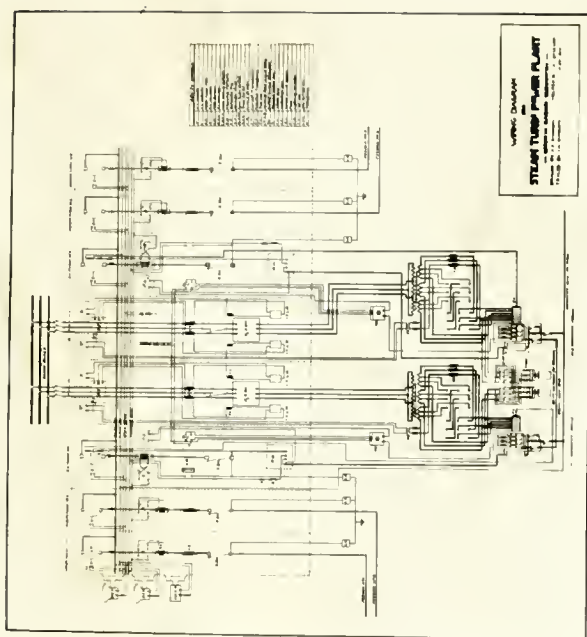
three controls for oil switches, one field circuit breaker control, one motor governor control, and one field rheostat control. Receptacles are provided for synchronizing, voltage, and frequency.

The high tension lines are both mounted on the same panel, which carries six ammeters and one voltmeter. A voltmeter receptacle gives the voltage on any phase. The keyboard carries: four oil switch controls, sectionalizing switch control, with a polyphase wattmeter and curve tracing voltmeter mounted on the back of the board.

The low tension power panels carry three ammeters, one recording wattmeter, and one control key. The three phase lighting feeder panels carry in addition a key for the section switches. The keyboard for the single phase feeders is provided with voltmeter receptacles by which the voltage at the end of the line can be read on the bracket voltmeter.

Synchroscope, frequency meter, and ground detector are mounted on brackets. Current transformers are on panels back of the main board. Circuit breakers are on small panels downstairs.







## SUBSTATION WIRING.

The converters receive power from the 2200 volt buses through step down transformers each of 375 K.W. connected together for six-phase diametral operation of converters. The voltage on the A.C. side is 400 volts, giving 650 volts on the D.C. side, an allowance of 50 volts being made for line drop. The converters are connected to the secondary of the transformers through two three-pole double-throw switches for starting and running. Voltage regulation is accomplished by induction coils. A field break up switch is mounted on a panel on the machine.

Each converter has its own A.C. starting panel and one D.C. panel, two feeder panels being connected on each side as shown in the wiring diagram. The A.C. panel carries one ammeter, one voltmeter, and one power factor meter. A  $K_2$  oil switch, current transformers, and inverse time limit relays are also on the board. The D.C. board carries two ammeters, one





for the main circuit and ~~one~~ for the field excitation. The field rheostat is distant controlled by a switch on the board. The panel also carries a General Electric circuit breaker, voltmeter receptacle, snap switch, and recording wattmeter.

Each feeder panel has one, ammeter, circuit breaker, kicking coil, and snap switch.

The switchboard is provided with two D.C. voltmeters and a curve tracing voltmeter, on brackets. The upper voltmeter is connected directly across the buses. The other voltmeter is connected across the terminals of either machine through a receptacle and is used for regulating the voltage before throwing the machine on the buses.



## TRANSMISSION LINE.

The two lines to each town are to be operated in parallel, each delivering 2025 K.W.

A receiver voltage was assumed at 31,500 volts for the line calculation. The first loss considered was a 10% loss. The loss per wire is equal to one sixth of this since there are two circuits in operation. The current per line to deliver 2025 K.W. at 31,500 volts was found to be 37.2 amperes. Since the loss is equal to  $I^2R$ , the resistance per wire can easily be calculated. For the above loss, this was found to 50.4 ohms. This gives a resistance drop of 1875 volts, which was considered as excessive for good regulation.

The next loss considered was 6%. The resistance per wire was found to be 28.4 ohms. The nearest size of aluminum wire was found to be a #0 stranded 62% conductivity wire. Aluminum was used on account of its lightness and greater tensile strength. The above wire has a resistance of



0.848 ohms per mile, giving a line resistance of 25.44 ohms. The corrected loss was found to be 5.2%.

It was decided to use wood poles with 150 foot spans and 36-inch spacing of wires. The "wishbone" type of steel crossarm is to be used, the highest wire being six inches below the top of the pole. A single ground wire is carried on top of the pole.

The line inductance was calculated from the following formula, which takes into account both self- and mutual-induction:

$$L = 2L_1 \left( \log_e \frac{2L_1}{r} + \frac{1}{4} - \log_e \frac{2L_1}{D} \right)$$

$L_1$  is the length of the line,  $r$  the radius of the wire, and  $D$  is the spacing of the wires. The inductance was found to be 0.0545 henry, giving an inductive reactance of 20.55 ohms. The capacity was calculated from the following formula:

$$C = \frac{38.8 \times 10^{-9}}{\log_{10} \frac{2D}{d}} \text{ farads per mile.}$$

The total capacity was found to be  $5.1 \times 10^{-7}$  farads,



giving a condensive reactance of 5200 ohms.

The natural frequency of the line was found

from the formula:  $\frac{1}{4\sqrt{LC}}$ , the factor 4 being

used instead of 6.28 because the capacity and inductance are distributed. The result was 1528 cycles per second. The charging current was found to be 3.5 amperes per line, or 7.0 amperes for the two lines. The apparent power in the line is then 382 KVA.

The regulation was calculated by the vector method, considering one half the capacity reactance concentrated at each end of the line. It was found that the capacity of the line had very little effect on the load voltage at no load, the resistance drop being the principal factor. The regulation for non-inductive full load is 5.15%, and for an 80% lagging current at full load is 6.5%.

The generator voltage for the non-inductive load is 33,250, and for the 80% power factor is 33,550 volts.



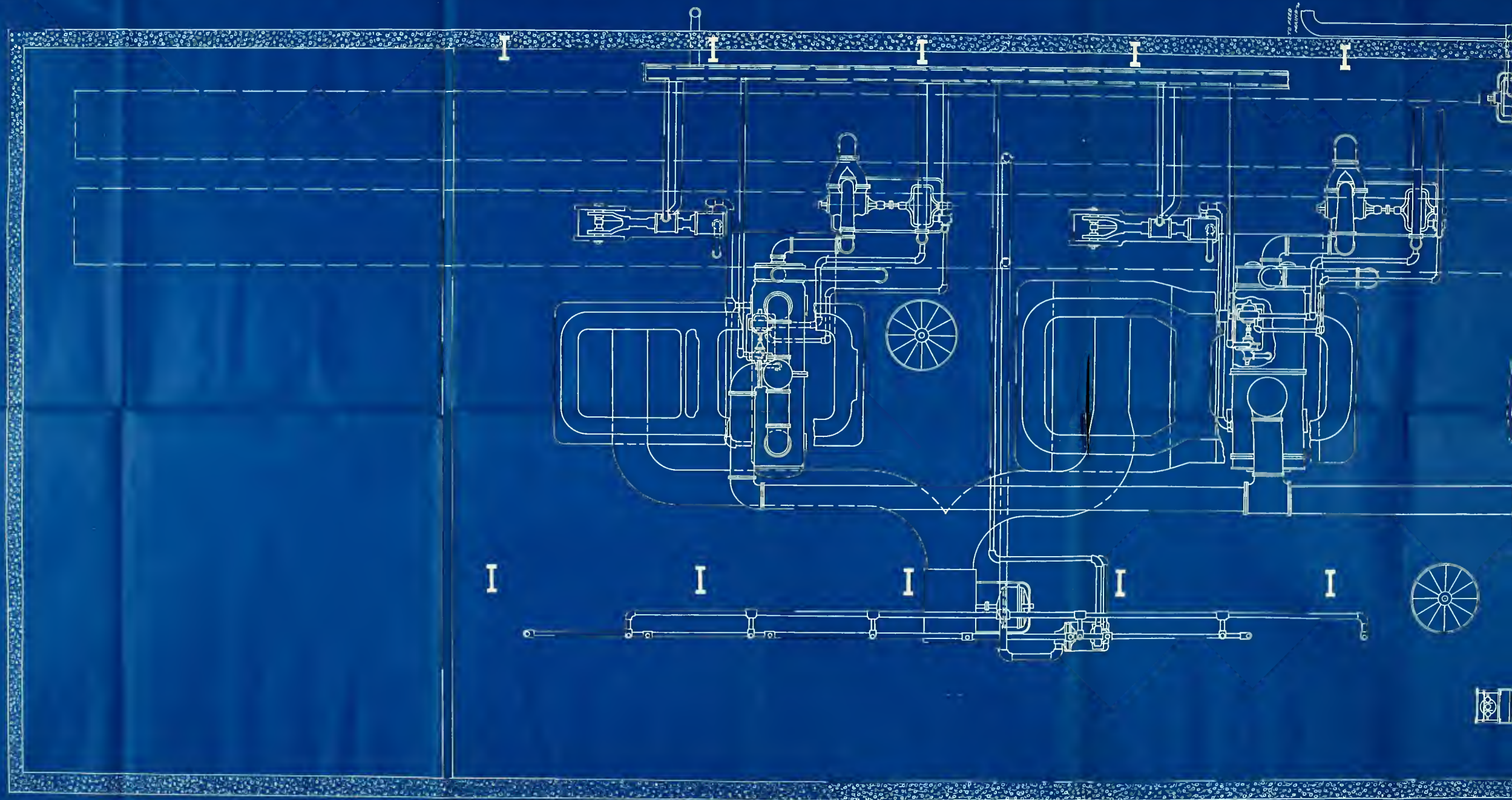




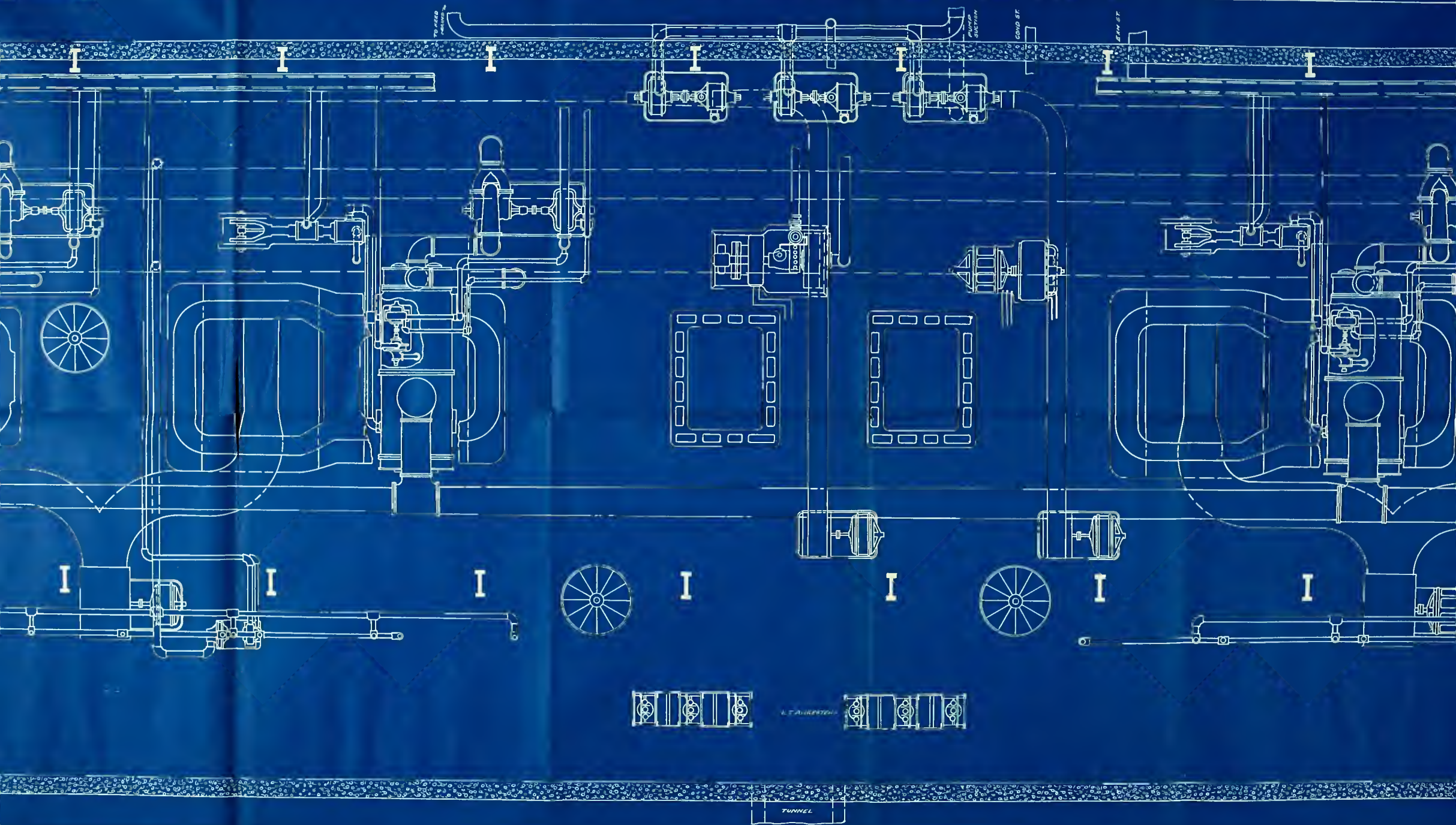




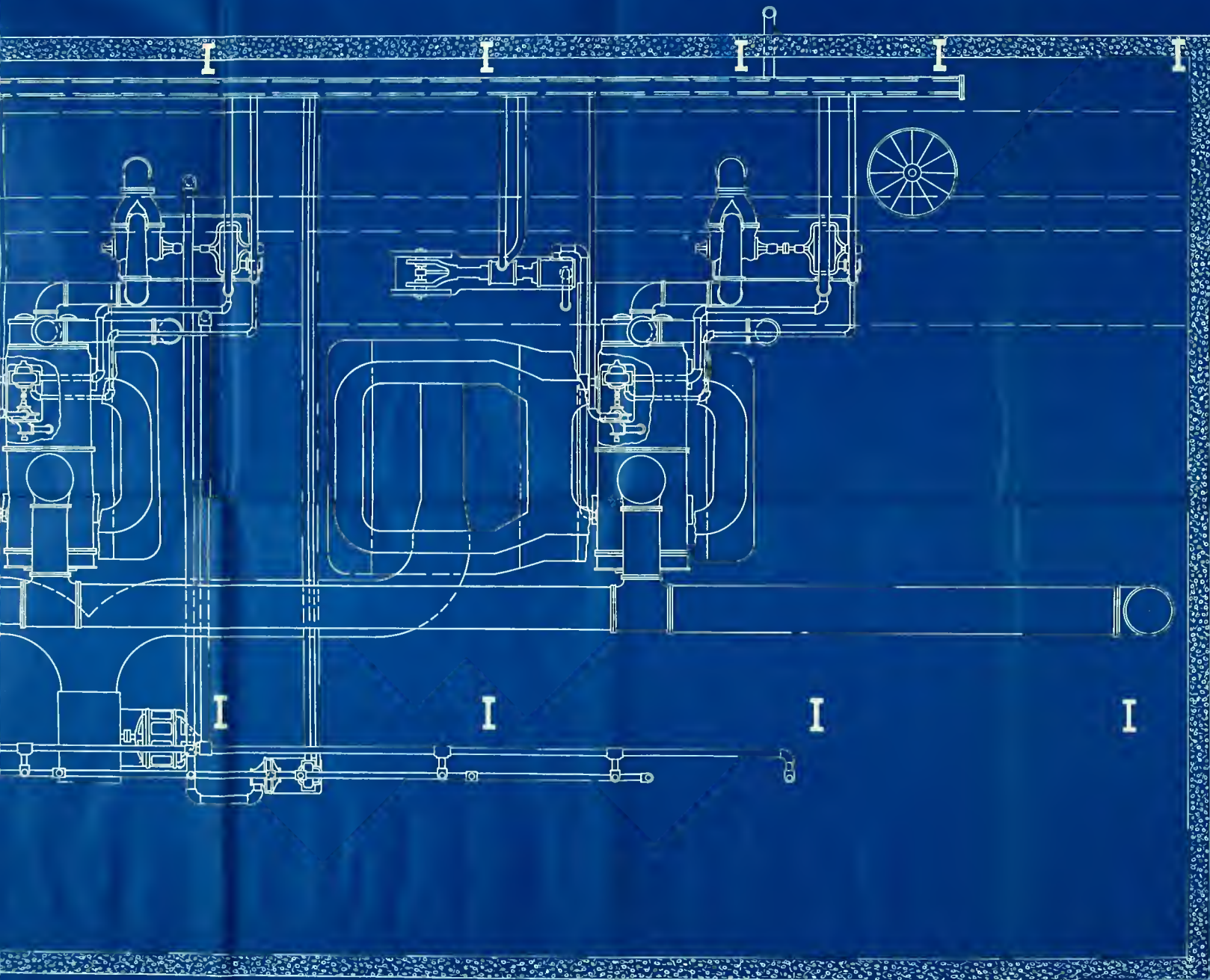












PLAN OF ENGINE BASEMENT  
FOR  
**STEAM TURBINE POWER PLANT.**

10,000 K.W.

DRAWN BY: M.V. STECHER.

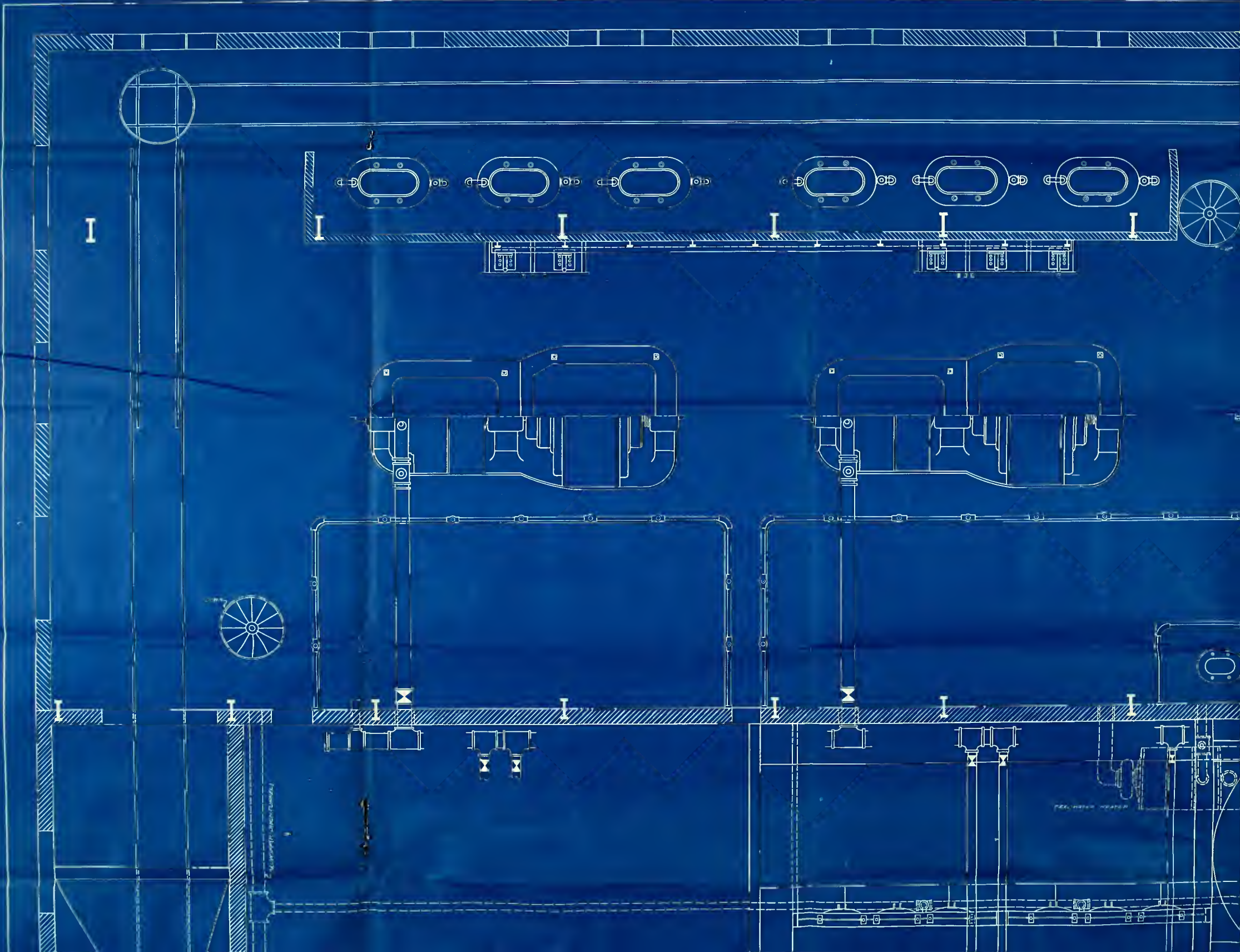
CHECKED BY: G. WETZEL.

TRACED BY: M.V. STECHER.

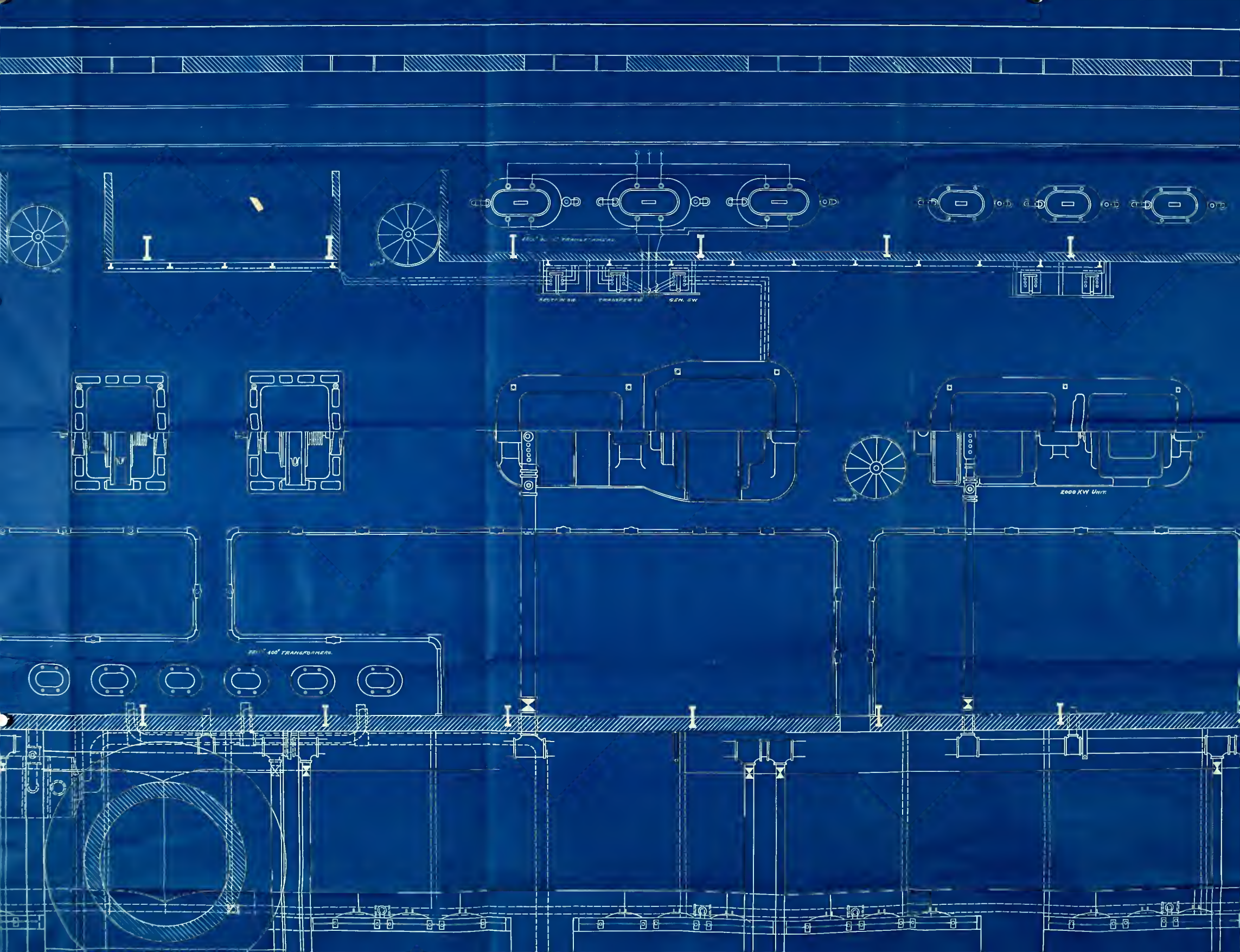
MAY, 1914.

SCALE:  $\frac{1}{4}'' = 1'$

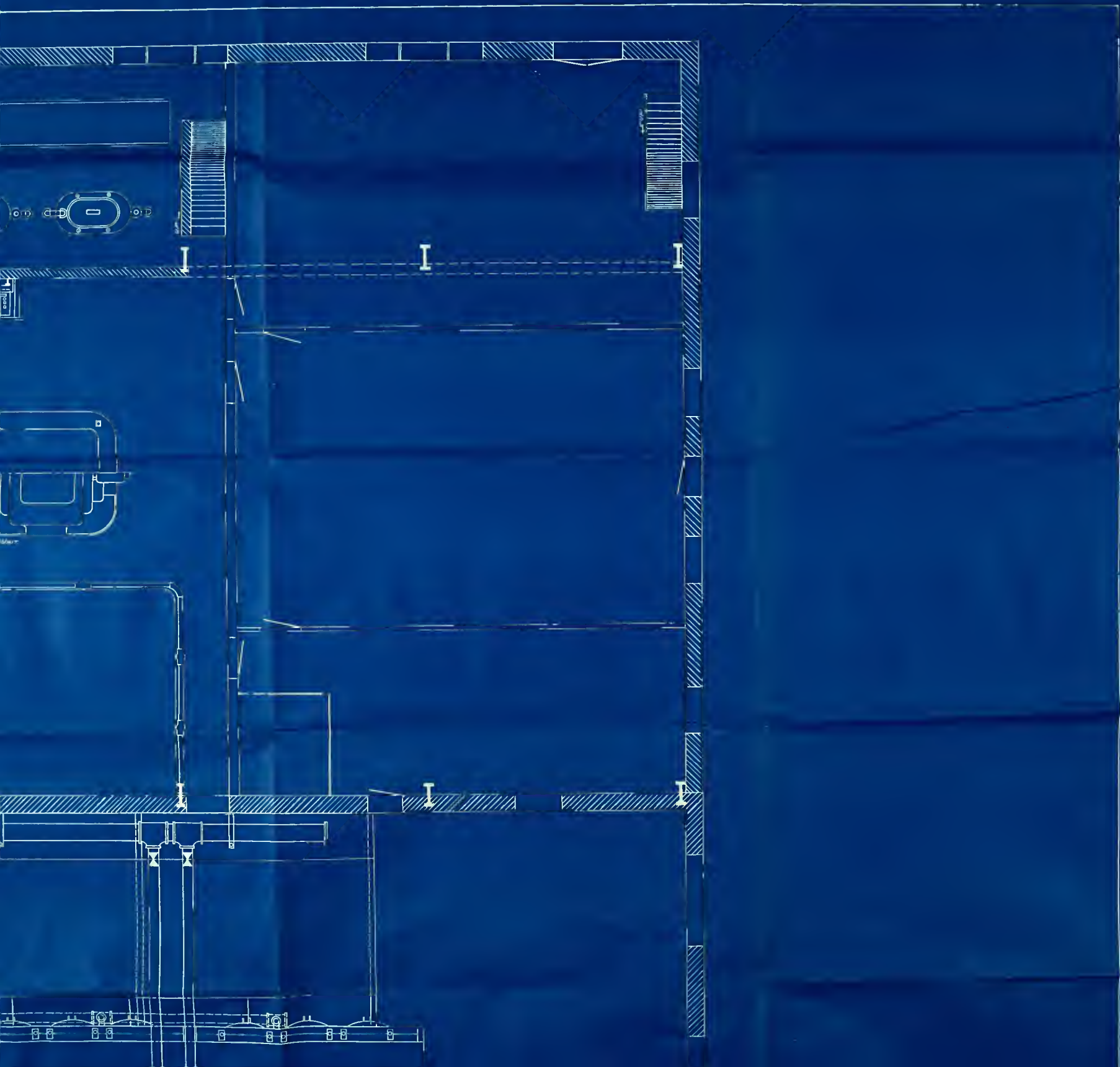




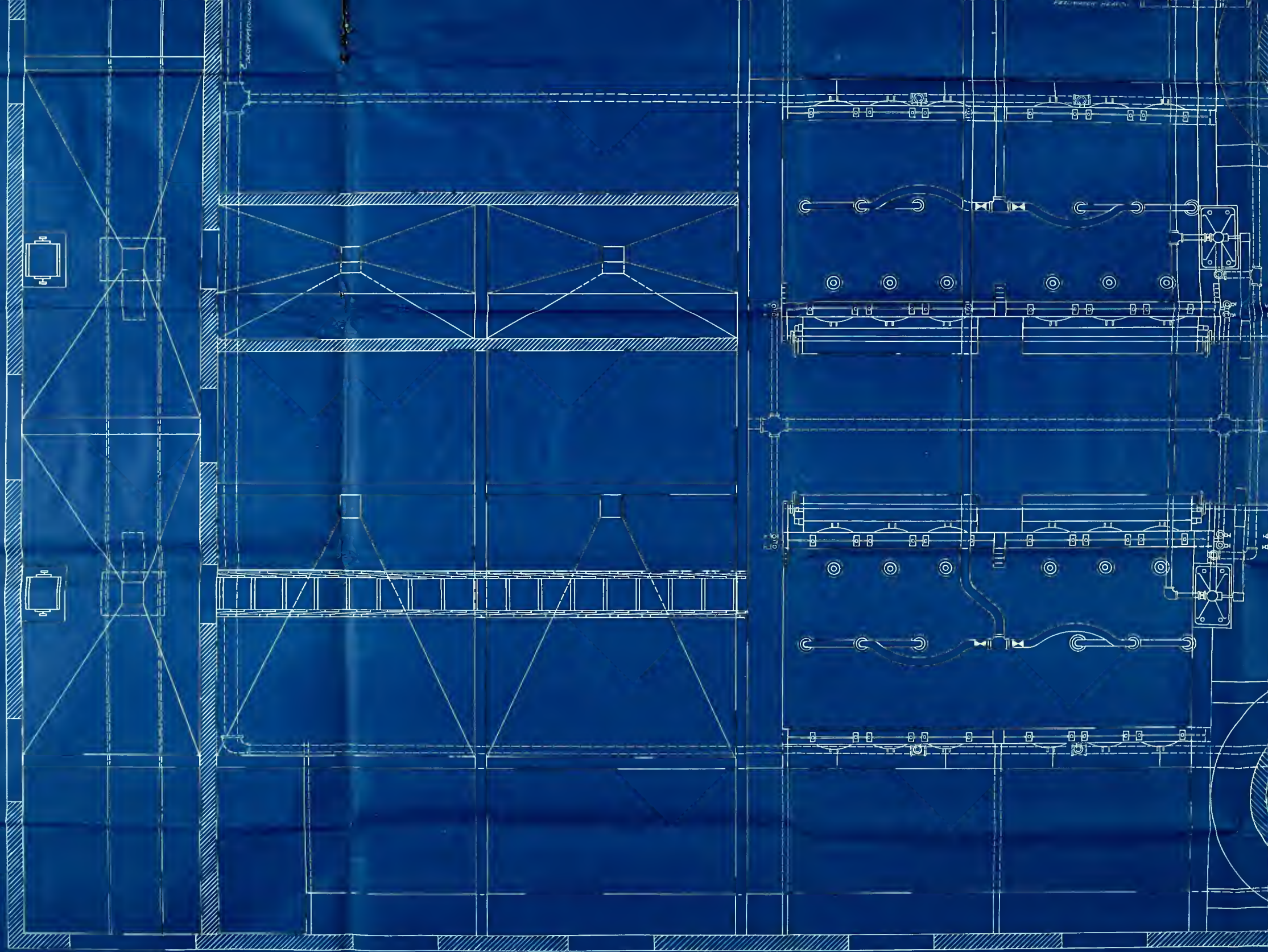




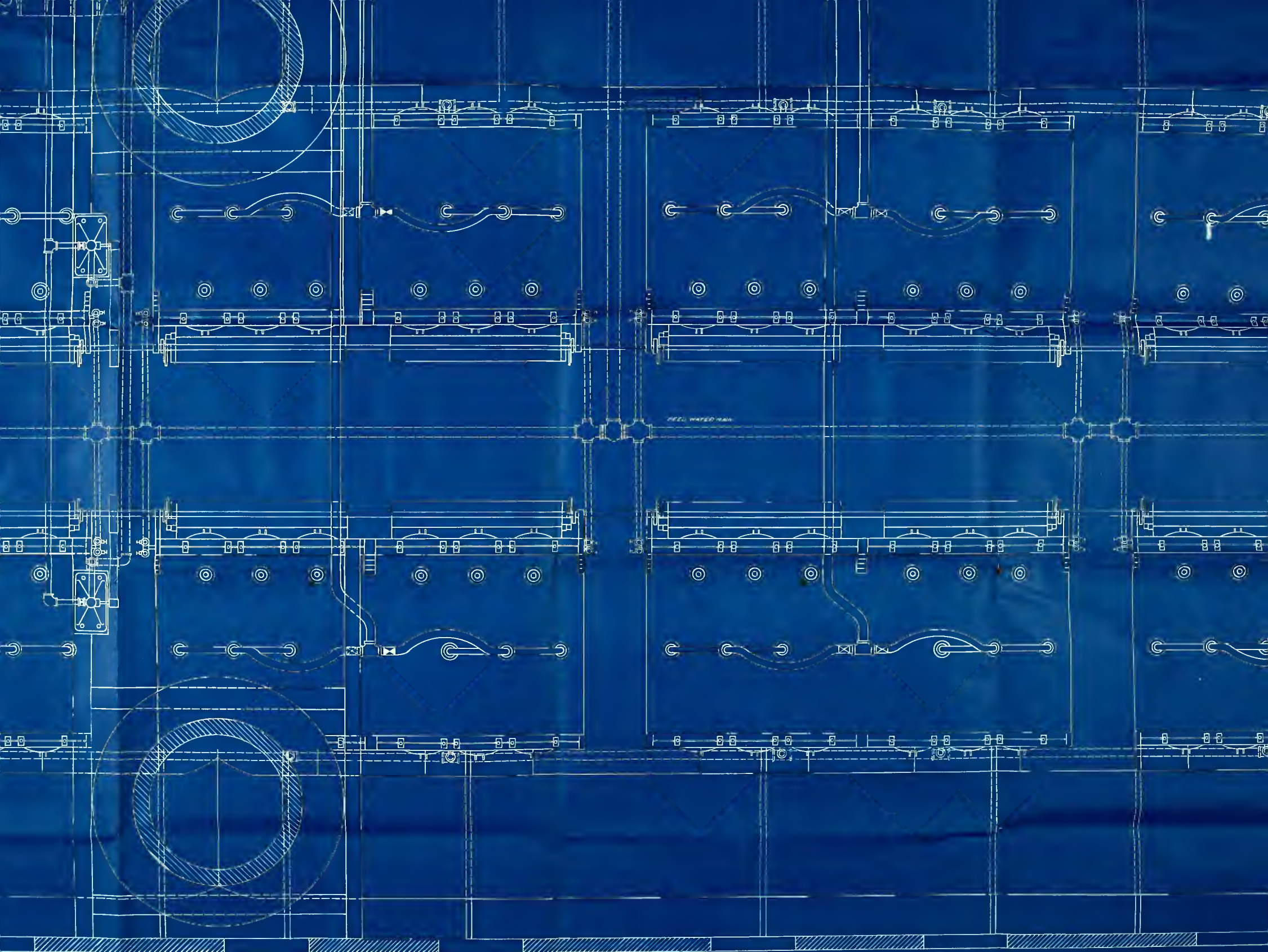




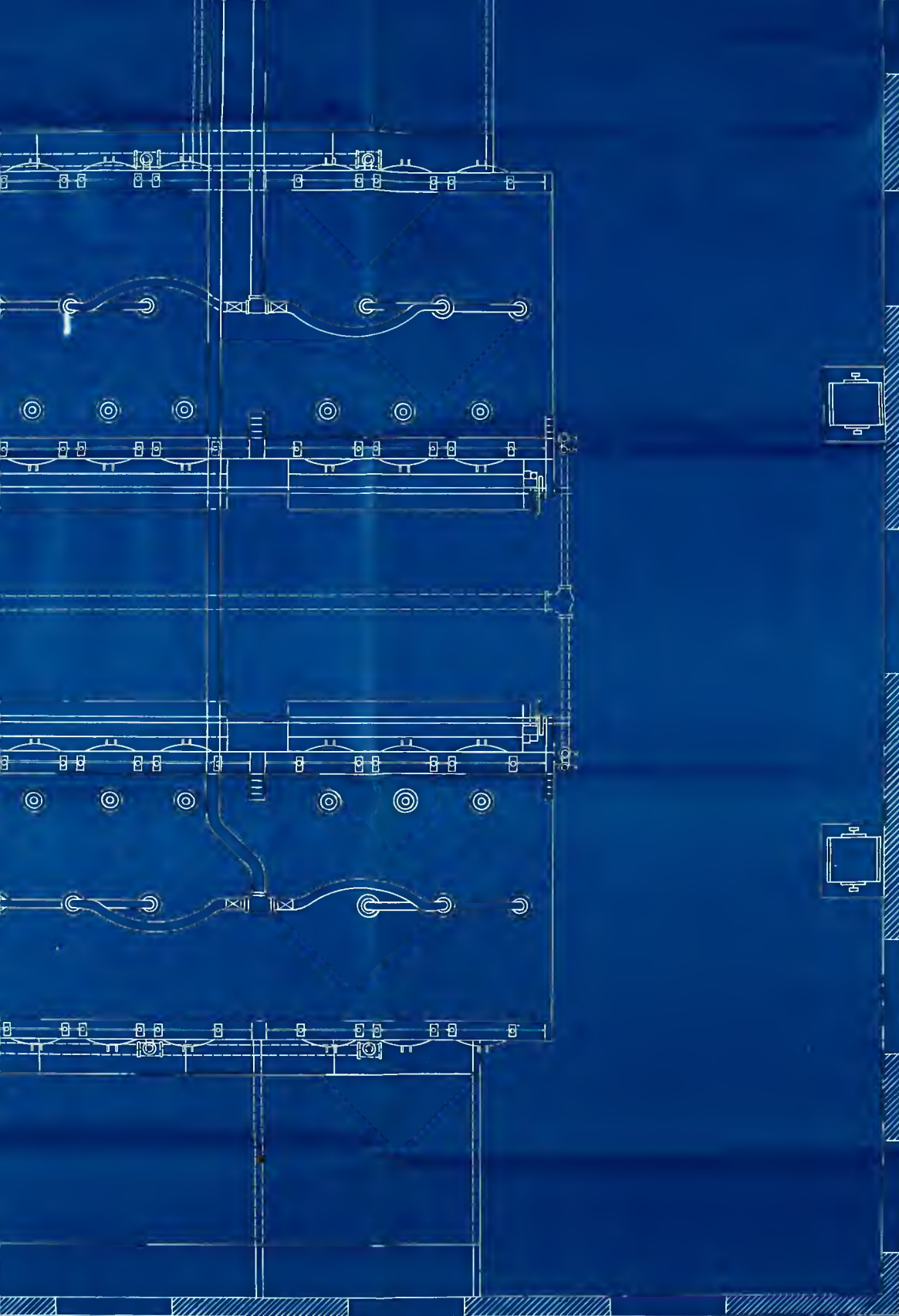








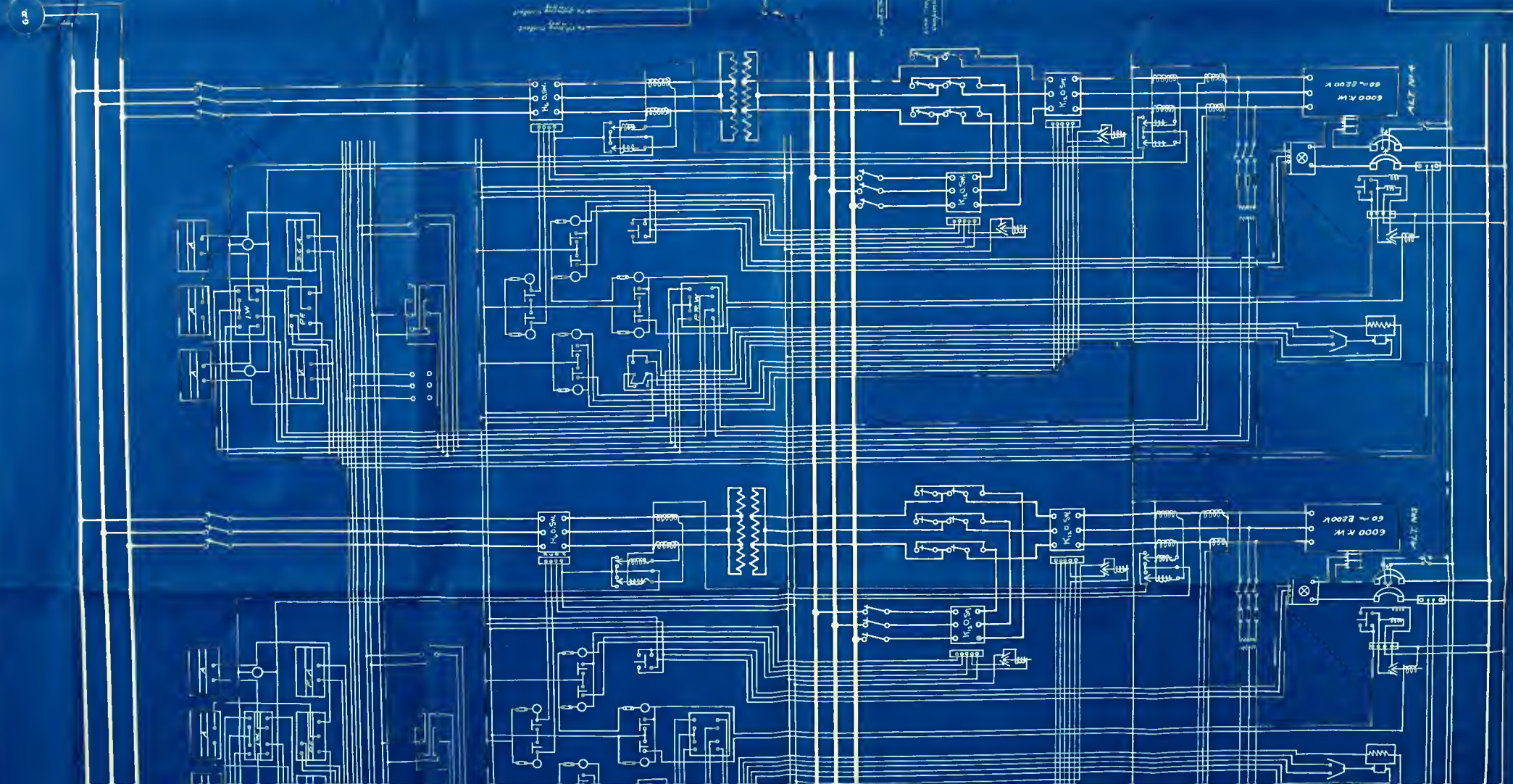




PLAN VIEW  
FOR  
**STEAM TURBINE POWER PLANT.**

13500 KW  
DRAWN BY: G. L. WETZEL. CHECKED BY: F. A. FAWCENSON  
TRACE 1 BY: G. L. WETZEL. MAY, 1945.  
SCALE:  $\frac{1}{4}'' = 1'$





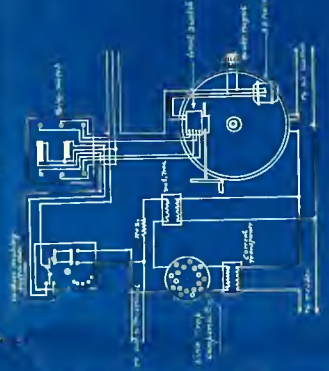
Additional connections of type in all sections



Additional connections of type in all sections



Connections of various types in all sections



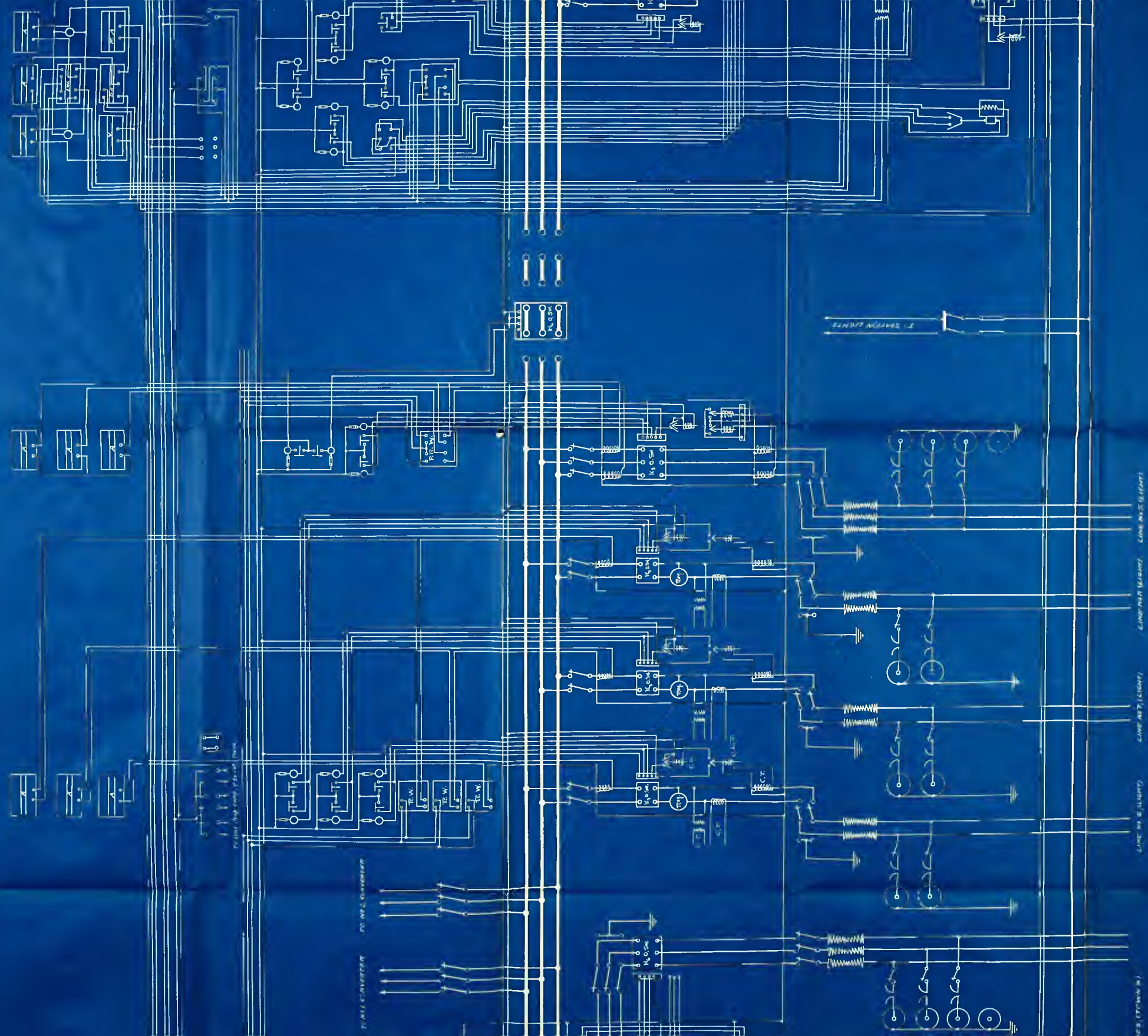
# WIRING DIAGRAM

FOR

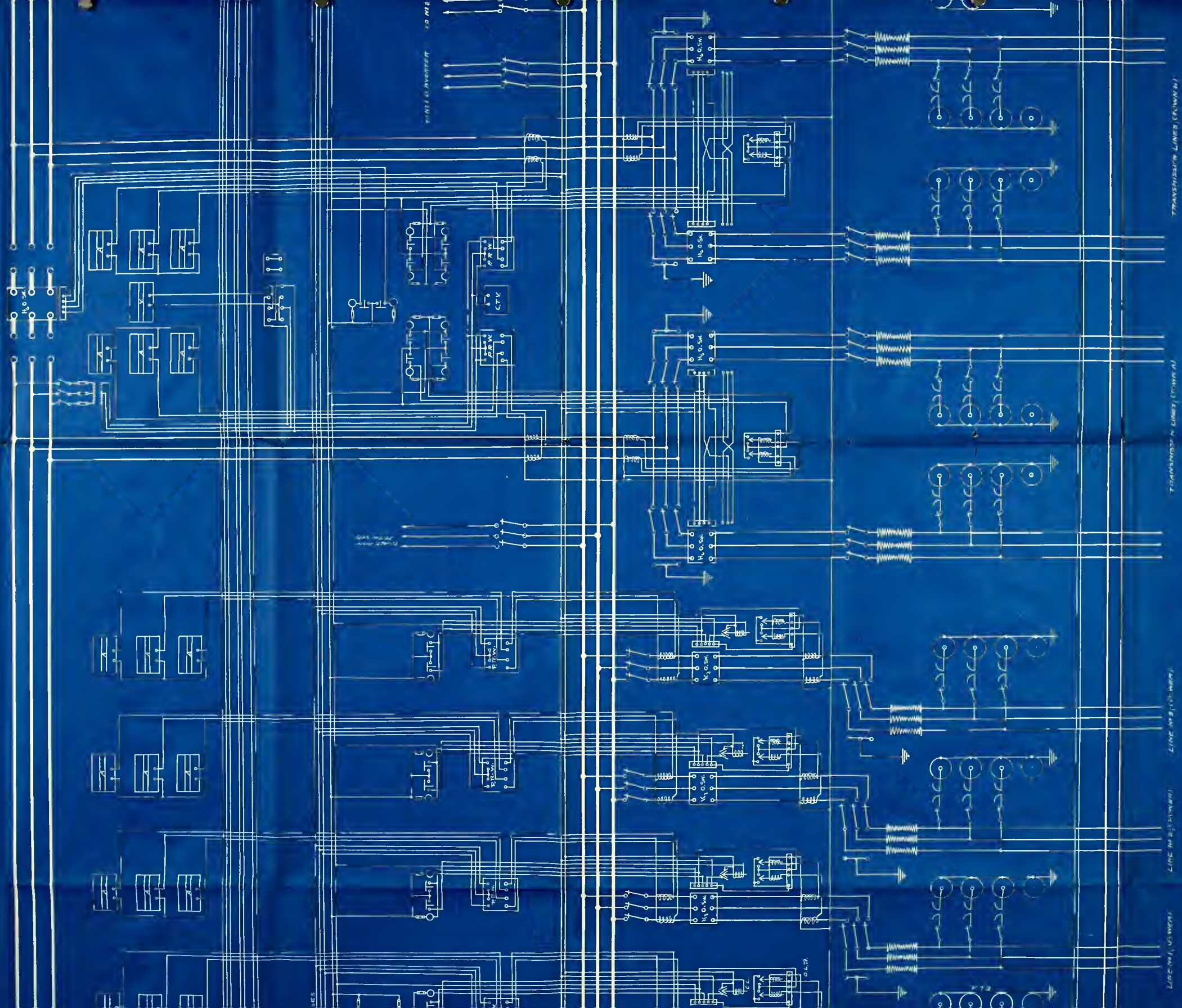
## STEAM TURBINE POWER PLANT

DRAWN BY: E. A. SWANSON  
 CHECKED BY: M. V. ESTERHART  
 MAY 1944









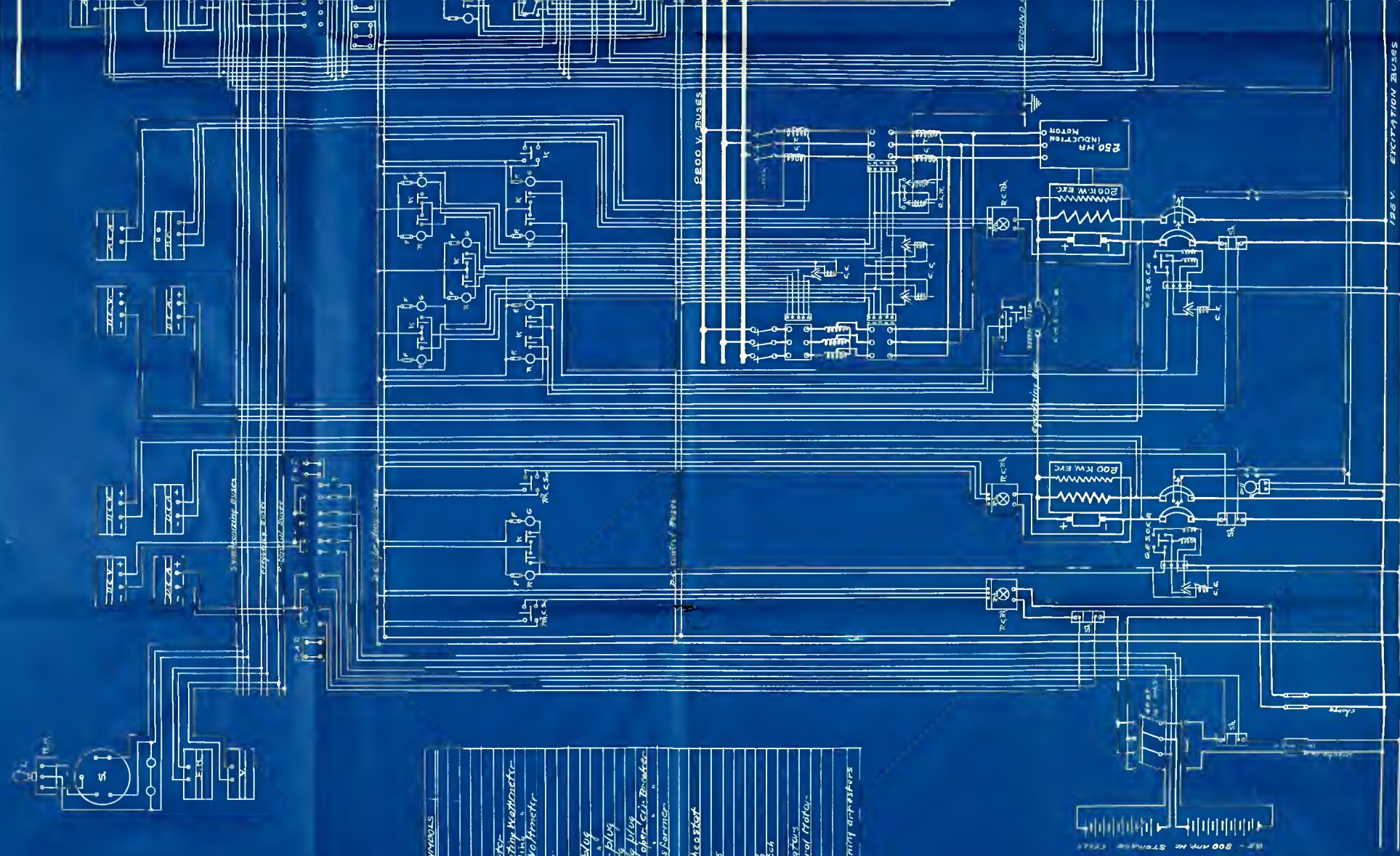








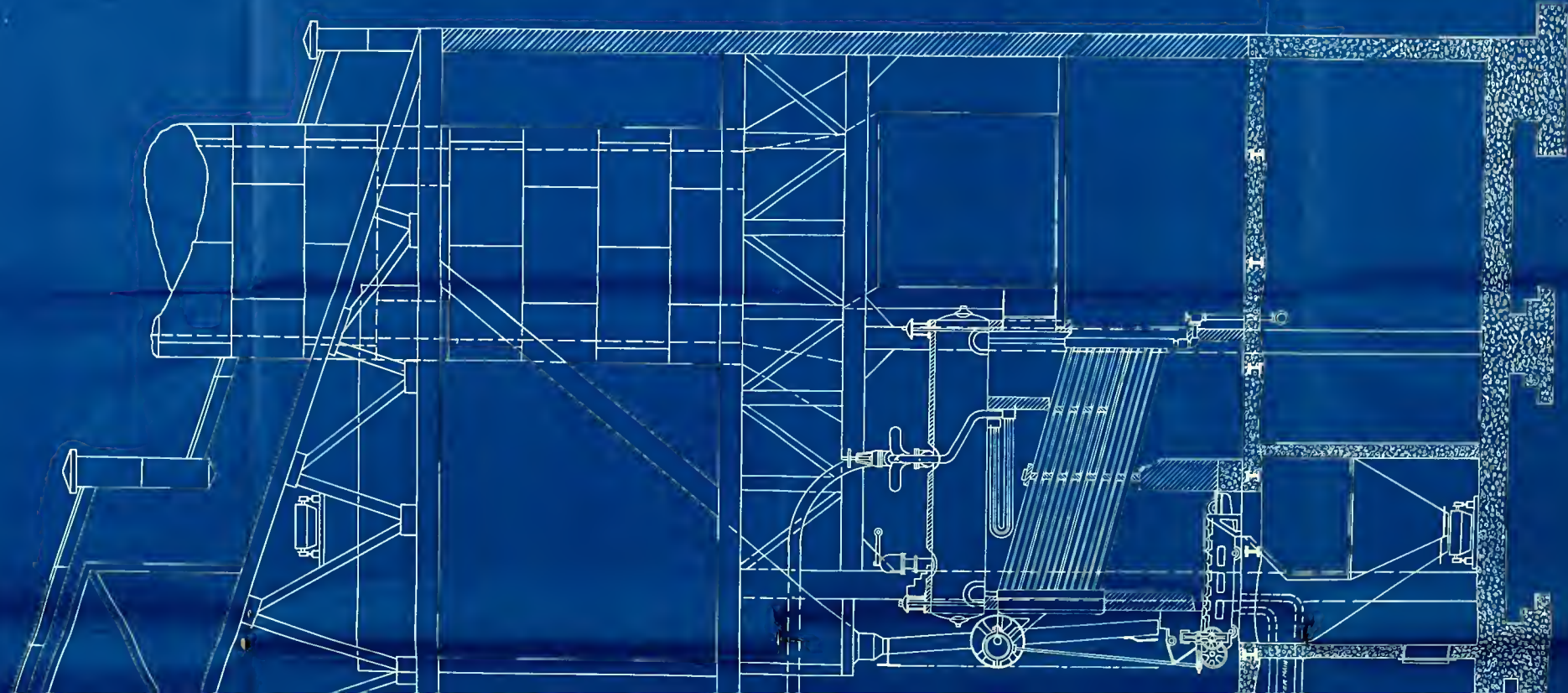
KEY TO SYMBOLS	
A	A.C. Ammeter
V	A.C. Voltmeter
D.C.A.	D.C. Ammeter
D.C.V.	D.C. Voltmeter
F.A.	Field Ammeter
P.F.	Power Factor Meter
P.W.	Power Factor Meter
I.W.	Power Factor Meter
C.D.V.	Curve Drawing Voltmeter
S	Resistor
SP	Frequency Meter
TR	Resistor
L	Lamp
L.A.P.	Ball Capacitor Plug
V.P.	" " " "
V.P.	" " " "
V.P.	" " " "
S.P.	Switching Plug
GEASCO	General Solenoid Oper. Coil Driver
C.T.	Current Transformer
P.T.	Potential " "
C.C.	Control Coil
TR.C.D.	Control Transformer
IL	Interlocking Keys
O.L.T.	Overload Trips
F	Fuse
TR	Transformer
S	Switch
S.W.	Selection Switch
A.D.W.	Automatic Oil Switch
TR.C.D.	Control Transformer
C.T.	Current Transformer
P.T.	Potential Transformer
H	Motor
CH.C.	Choke Coil
E.L.A.	Electric Lighting Apparatus











SECTIONAL ELEVATION

FOR

**STEAM TURBINE POWER PLANT.**

13500 KW.

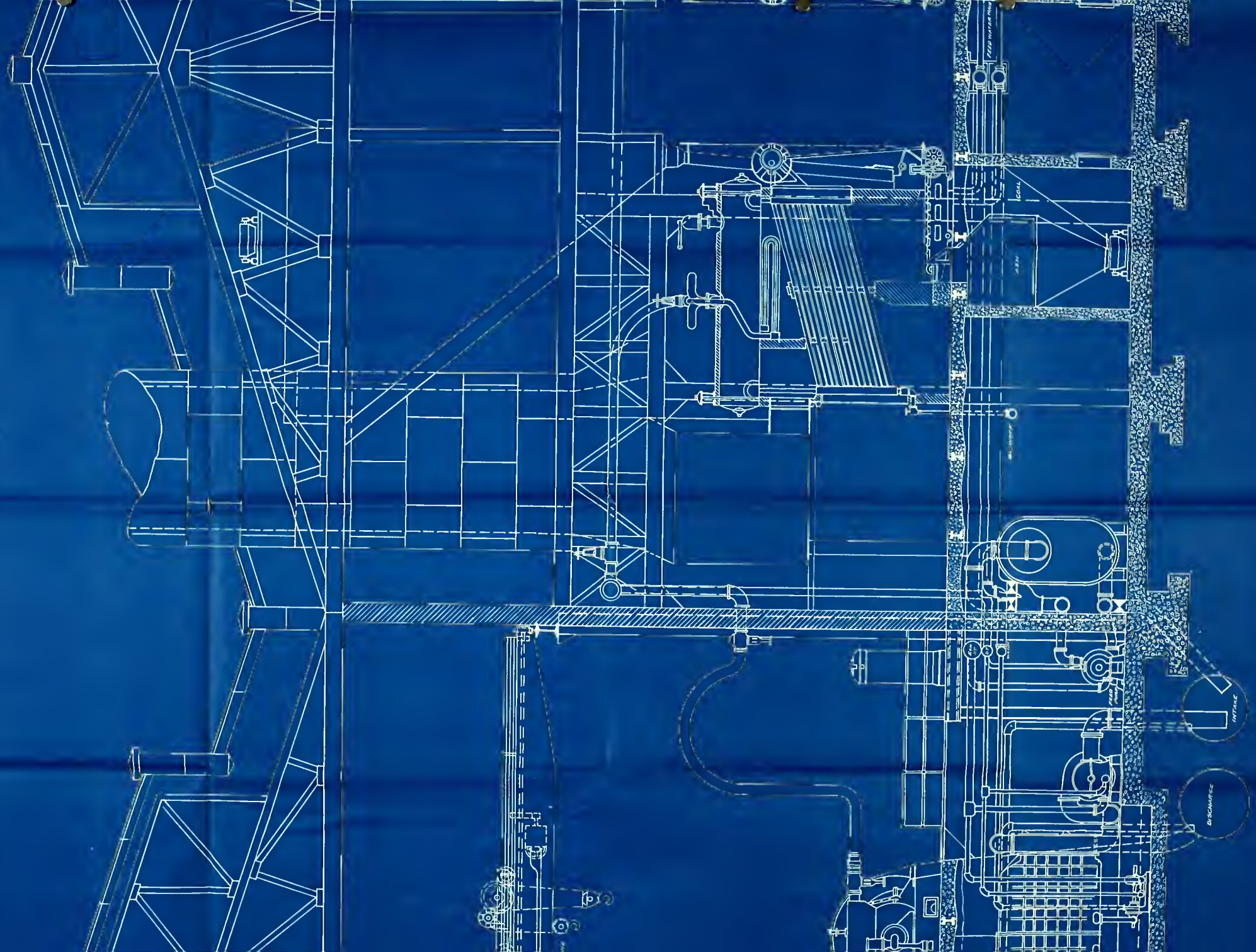
DRAWN BY MYSTECHEP

CHECKED BY CL. WESTZEL

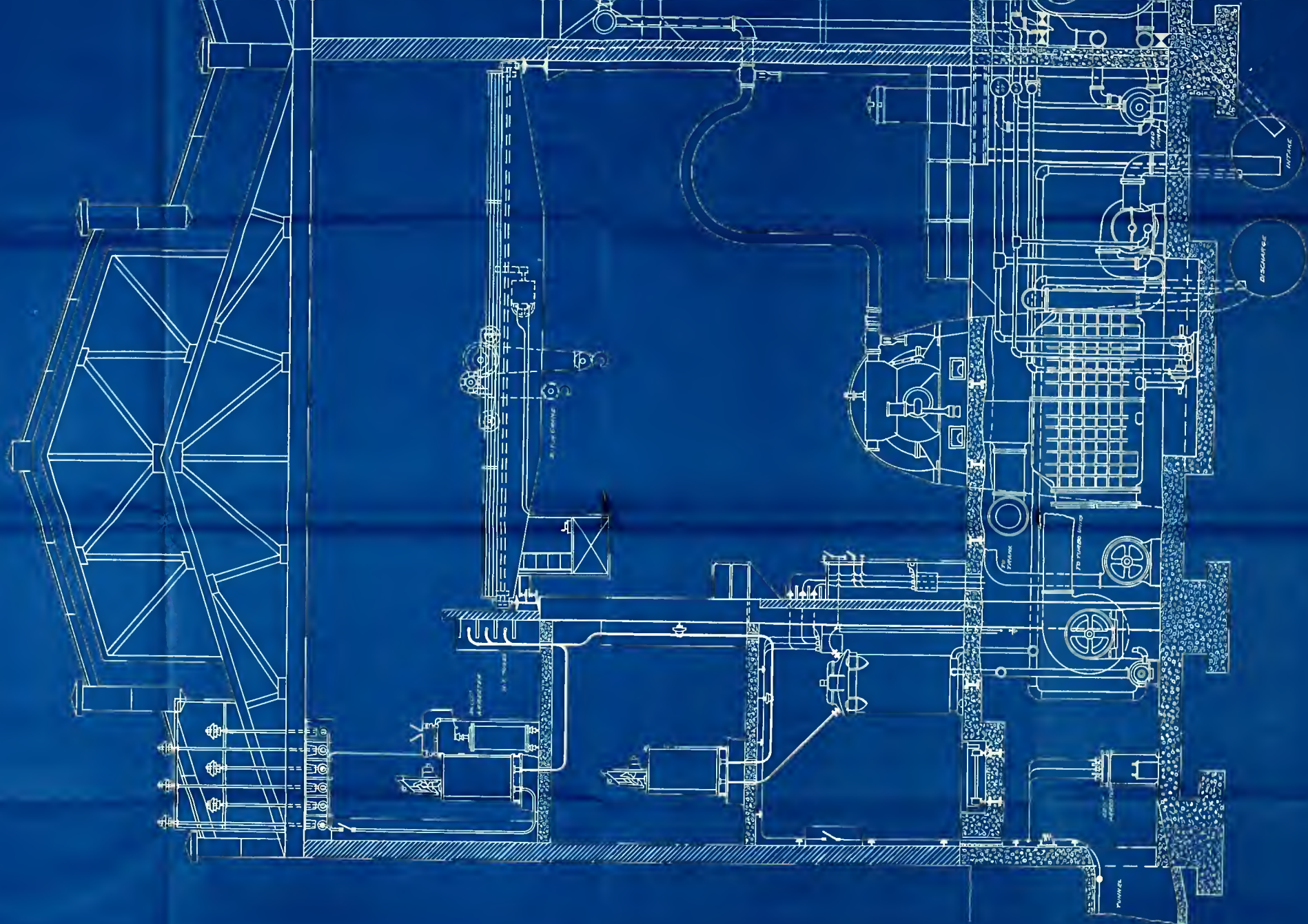
MAY, 1914.

SCALE: 1" = 1'

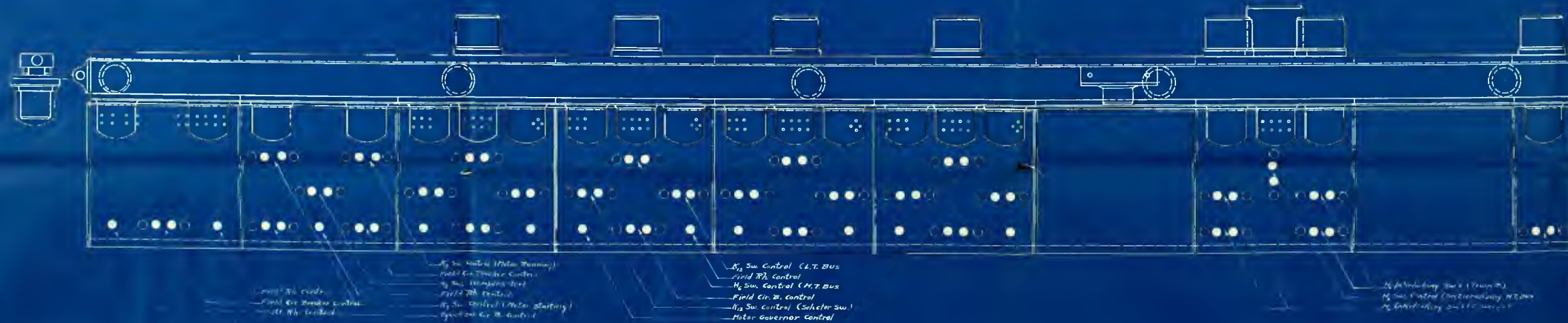
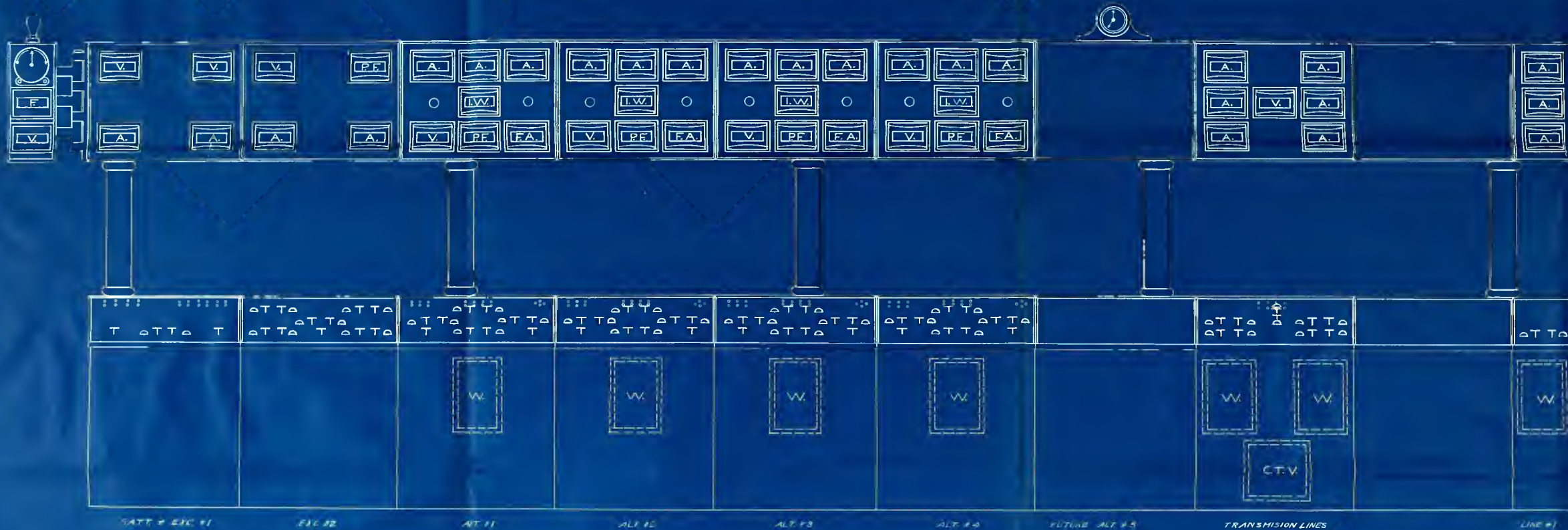
















LINE #1      LINE #2      LINE #3      LINE #4      LINE #5      LINE #6



## STEAM TURBINE POWER PLANT

— 15500 K.W. —

DRAWN BY: F. A. SWANSON  
TRACED BY: F. A. SWANSON

Spencer

1. *Introducing Sam (1 min 30)*  
 2. *Sam's School (Introducing to 2 min)*  
 3. *Introducing Sam (1 min 30)*

$H_2$  low control  
 $H_2$  low control, (rectifier utilizing L.R. box)



